

## Influence of Nitrogen Fertilization and Foliar Spraying with Chelated Iron on Growth and Quality of Faba Bean in Sandy Soils

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**Abstract:** Two field experiments were conducted during 2019/2020 and 2020/2021 seasons at El-Qasasin district in Ismailia Governorate to study the effect of four nitrogen fertilization treatments namely 20, 40, 60 and 40 Kg N/fad plus spraying with 1% urea as well as three concentrations of chelated iron (12.5% Fe) as foliar spraying namely tap water (control), 750 and 1500 ppm on growth and quality of faba bean (*Vicia faba* L.) Nubaria 3 variety in sandy soils of Ismailia Governorate. All growth characters namely plant height, number of branches per plant, leaves area per plant, leaf area index, total dry weight of plant and total chlorophyll content in leaves as well as seed crude protein percentage of faba bean were significantly increased by raising nitrogen fertilization rate up to 60 Kg N /fad, which also exceeded significantly the treatment of 40 Kg N/fad plus spraying with 1% urea. Increasing chelated iron concentration as foliar spraying up to 1500 ppm statistically increased all aforementioned characters. The interaction between nitrogen fertilization and foliar spraying with chelated iron affected significantly all aforementioned characters. The highest values of the studied characters produced from faba bean plants received 60 Kg N/fad and sprayed with 1500 ppm chelated iron.

**Keywords:** Faba bean, Nitrogen, Iron, Fertilization, Foliar spraying, Growth traits, Yield quality

### INTRODUCTION

Faba bean (*Vicia faba* L.) is considered the most important seed leguminous crop grown in Egypt for human nutrition because of its rich seeds in protein which are consumed green (fresh) or dry. A great amount of faba bean seeds are consumed daily as human foods.

In Egypt, the consumption of faba bean is higher compared to the production, therefore Egypt import it's from several countries.

Increasing the area devoted to faba bean in the Nile valley is very difficult due to great competition from other winter crops and its lower net income compared to these crops such as berseem and wheat. Therefore, expanding faba bean area should be taken in newly reclaimed sandy soils which facing many problems like low fertility especially in nitrogen and iron, poverty and high loss of nutrients by leaching.

Nitrogen is the most important essential nutrient in plant nutrition, it is a constituent of a large number of necessary organic compounds including amino acids, proteins, coenzymes, nucleic acids (DNA and RNA), ribosomes, chlorophyll, cytochrome and some vitamins (Marschner, 1986).

Although faba bean plants are legumes, a low rate of N fertilizer may be needed for early growth and during the entire growing season when symbiotic nitrogen fixation by root nodules bacteria is inhibited (Eaglesham *et al.*, 1983).

Maximum yield of faba bean crop cannot be obtained depending on symbiotically fixed N alone but nitrogen supply was required (Leng, 1973). Moreover, the sandy soils are suffering from nitrogen deficiency which in turn affects the yield potentiality negatively. Therefore, an adequate supply of N is essential to obtain maximum yield under sandy soil condition.

The positive effect of supplying faba bean with nitrogen fertilization on growth and yield quality were emphasized by Diaz and Manrique (1995), Shaaban *et al.* (2006), Fathy *et al.* (2007), El-Howeity *et al.* (2009), Osman *et al.* (2010), Sadek (2010), Bozorgi *et al.* (2011), Abou-Elela and Gadallah (2012), El-Khateeb *et al.* (2012), Ghalwash *et al.* (2012), El-Tantawy and Nawar (2013), Mohamed *et al.* (2013), Abou-Amer *et al.* (2014), Ashoori (2014), Fouda *et al.* (2015), Adak and Kibritci (2016), Abd El-Haleem *et al.* (2019), Basdemir *et al.* (2020) and Elnesairi and Essalem (2020).

Iron is considered one of the most important micronutrients for plants. It is a component of many enzymes such as catalase, peroxidase and cytochrome oxidase. Also, Iron is required for synthesis of chlorophyll, proteins and chloroplastides, beside it enhances several metabolic processes namely photosynthesis rate and nitrogen fixation by root nodules bacteria. Moreover, it regulates respiration (Marschner, 1986).

On the other hand, iron content in sandy soils is too low to face the plant requirements of this nutrient as well as iron fertilizers is high loss by fixation or leaching in sandy soils. Therefore, application of iron as foliar spraying is readily absorbed by the leaves and not lost through fixation, decomposition or leaching.

The beneficial effect of foliar spraying with iron on growth and yield quality of faba bean were recorded by El-Gizawy (2003), Abdo and Attia (2007), Fusial *et al.* (2012), Abd El-Razek *et al.* (2013), El-Tantawy and Nawar (2013), Al-Hiji (2014), Salem *et al.* (2014), Abdel-Salam (2018), Al-Zubaidy and Al-Bawee (2018), Alabboudh and Saad (2019), Attiya *et al.* (2019), El-Shafey *et al.* (2019), Fadhil and Jader (2020), Nour El-Din *et al.* (2020) and El-Mansy *et al.* (2021).

Therefore, the objective of this study was to investigate the response of growth characters and yield

quality of faba bean Nubaria 3 variety to nitrogen fertilization and foliar spraying with chelated iron in sandy soils at Ismailia Governorate.

## MATERIALS AND METHODS

Two field experiments were conducted during 2019/2020 and 2020/2021 seasons at EI-Qasasin district in Ismailia Governorate to study the effect of nitrogen fertilization and spraying with chelated iron on growth and yield quality of faba bean (*Vicia faba* L.) Nubaria 3 variety.

The soil of the experiments was sandy with pH values of 7.46 and 7.41 and contained 3.84 and 4.11 ppm available N, 1.72 and 1.76 ppm available P, 10.34 and 10.99 ppm available K and 0.10% and 0.12% organic matter in the two seasons, respectively.

Each experiment included 12 treatments, which were the combinations of four nitrogen fertilization treatments and three chelated iron concentrations as foliar spraying.

The experimental design was split plots with four replicates. Four nitrogen fertilization treatments arranged randomly in the main plots, while the three chelated iron treatments were allocated at random in the sub plots.

Each experimental sub plot consisted of six ridges, 4.5 meter in length and 50 cm in width (plot area was 13.5 m<sup>2</sup>).

The preceding crop was sesame in both growing seasons.

Seeds of faba bean Nubaria 3 variety were sown on one side of the ridge in hills 10 cm apart on October 29 in the two seasons. After 24 days from sowing faba bean plants were thinned to two plants per hill.

Seeds were coated by Arab gum and inoculated with the specific Rhizobium strain immediately before sowing.

Four nitrogen fertilization treatments were 20, 40 and 60 kg N/fad as well as 40 kg N/fad plus spraying with 1% urea (46% N).

Nitrogen in the form of ammonium sulphate (20.5% N) was applied at three equal doses, after thinning, 65 and 78 days from sowing.

Foliar spraying with 1% urea was sprayed twice after 58 and 68 days from sowing with volume spray of 400 Liter/fad.

A basal dose of calcium superphosphate (15.5% P<sub>2</sub>O<sub>5</sub>) at rate of 200 kg/fad was applied at two equal doses. The first dose during soil preparing and the second one at 55 days from sowing

A basal dose of potassium sulphate (48% K<sub>2</sub>O) at rate of 150 kg/fad was applied at three equal doses, after thinning, 55 and 78 days from sowing.

Chelated iron (12.5% Fe) at three concentrations namely tap water (control), 750 and 1500 ppm were conducted as foliar spraying.

Foliar spraying with chelated iron was done three times after 25, 45 and 66 days from sowing with volume spray of 400 Liter/fad.

The normal cultural practices for growing faba bean crop at Ismailia Governorate were followed.

After 96 days from sowing, samples of five guarded plants were randomly taken from the second ridge of each sub plot to estimate the following characters namely plant height (cm), number of branches/plant, leaves area per plant (cm<sup>2</sup>) using dry weight method according to Rhoads and Bloodworth (1964), leaf area index (LAI) accounted by dividing leaves area per plant on land area occupied by one plant, total dry weight per plant (g) and total chlorophyll content in leaves by SPAD values. The SPAD-502 chlorophyll meter (Minolta Co., Ltd., Japan), a portable self-calibrating convenient and non-destructive device which can be used for measuring the amount of chlorophyll present in plant leaves (Yadava, 1986; Minolta, 1989).

At harvest time, after 173 days from sowing, samples of ten guarded plants were randomly taken from the two inner ridges in each sub plot to determine seed crude protein percentage as a total nitrogen (%) of the faba bean seeds using the modified Micro-Kjeldahl Apparatus according to A.O.A.C. (1990), then the obtained values were multiplied by 6.25 (Tripathi *et al.*, 1971).

The analysis of variance of split plots design was used according to Snedecor and Cochran (1982). Differences between treatments means were compared using Duncan's Multiple Range Test (Duncan, 1955). Means followed by the same alphabetical letters are not statistically different according to Duncan's Multiple Range Test at the 5% level of significance (Duncan, 1955). Means of the interaction were compared using the Least Significant Difference (LSD) Test (Waller and Duncan, 1969).

## RESULTS AND DISCUSSION

### A- Effect of nitrogen fertilization:-

Data in Table (1) reveal that increasing nitrogen fertilization level from 20 to 40 and 60 kg N/fad significantly increased plant height at 96 days from sowing. Also, the high nitrogen level (60 kg N/fad) significantly surpassed the treatment of 40 kg N/fad plus spraying with 1% urea and that held true in the two seasons.

Fertilizing faba bean with 40 kg N/fad plus spraying plants with 1% urea reflected increase in plant height at 96 days from sowing compared to 40 kg N/fad insignificant in the first season and significant in the second season (Table 1).

The relative increases in plant height at 96 days from sowing by applying 60 kg N/fad compared to 40 kg N/fad plus spraying with 1% urea, 40 and 20 kg N/fad were 18.37%, 23.04% and 48.90%, respectively in the first season 2019/2020 and 19.48%, 27.94% and 55.54%, respectively in the second season 2020/2021 (Table 1).

**Table (1):** Effect of nitrogen fertilization, spraying with chelated iron and their interaction on plant height (cm) at 96 days from sowing during the two seasons of 2019/2020 and 2020/2021

Chelated iron (ppm)	Nitrogen fertilization (Kg N /fad)				Average
	20	40	60	40+urea	
<b>2019/2020 season</b>					
Tap water	27.09	32.84	40.15	33.95	33.51 C
750	29.14	35.32	43.50	36.69	36.16 B
1500	31.24	37.70	46.59	39.39	38.73 A
Average	29.16 C	35.29 B	43.42 A	36.68 B	
L.S.D 0.05 (N x Fe)					1.40
<b>2020/2021 season</b>					
Tap water	27.32	33.25	42.29	35.00	34.47 C
750	29.49	36.00	45.49	37.79	37.19 B
1500	31.76	38.44	50.00	42.53	40.68 A
Average	29.53 D	35.90 C	45.93 A	38.44 B	
L.S.D 0.05 (N x Fe)					1.68

The positive effect of nitrogen fertilization on plant height might be attributed to that N encourages cell elongation and division in turn increases number and length of internodes resulting taller plants. These results are concordant with those concluded by Shaaban *et al.* (2006) who stated that plant height of faba bean was increased by increasing N rate up to 40 Kg N/fad, Bozorgi *et al.* (2011) up to 60 Kg N/ha, Abou-Elela and Gadallah (2012) up to 110 Kg N/fad, Mohamed *et al.* (2013) up to 45 Kg N/fad, Basdemir *et al.* (2020) up to 40 Kg N/ha and Elnesairi and Essalem (2020) up to 150 Kg N/ha.

Data presented in Table (2) illustrate that number of branches per plant at 96 days from sowing increased statistically by increasing nitrogen fertilization rate up to 60 Kg N/fad, the last treatment deviated in this respect significantly with 40 Kg N/fad plus spraying with 1% urea and that was true in the two seasons.

Fertilizing faba bean with 40 Kg N/fad plus spraying with 1% urea significantly surpassed 40 Kg N/fad in number of branches per plant at 96 days from sowing during the two seasons (Table 2).

**Table (2):** Effect of nitrogen fertilization, spraying with chelated iron and their interaction on number of branches /plant at 96 days from sowing during the two seasons of 2019/2020 and 2020/2021

Chelated iron (ppm)	Nitrogen fertilization (Kg N /fad)				Average
	20	40	60	40+urea	
<b>2019/2020 season</b>					
Tap water	1.92	2.38	2.91	2.61	2.46 C
750	2.16	2.69	3.32	2.97	2.79 B
1500	2.42	3.00	3.69	3.27	3.10 A
Average	2.71 D	2.69 C	3.31 A	2.95 B	
L.S.D 0.05 (N x Fe)					0.082
<b>2020/2021 season</b>					
Tap water	1.94	2.40	2.64	2.64	2.48 C
750	2.17	2.71	3.36	3.00	2.81 B
1500	2.44	3.02	3.74	3.28	3.12 A
Average	2.19 D	2.71 C	3.34 A	2.97 B	
L.S.D 0.05 (N x Fe)					0.086

Faba bean plants received 60 Kg N/fad exceeded those treated by 40 Kg N/fad plus spraying with 1% urea, 40 and 20 Kg N/fad in number of branches per plant at 96 days from sowing by 12.20%, 23.05% and 52.53%, respectively in the first season and 12.46%, 23.25% and 52.51%, respectively in the second season (Table 2). These results were expected since nitrogen favours meristematic tissues, photosynthesis rate and metabolites synthesized by the leaves consequently increases number of branches per plant.

In harmony with these results, Fathy *et al.* (2007) demonstrated that number of branches per plant was increased by increasing nitrogen level up to 50 Kg N/fad, El-Howeity *et al.* (2009) up to 40 Kg N/fad, Ghalwash *et al.* (2012) up to 30 Kg N/fad, Abou-Elela and Gadallah (2012) up to 110 Kg N/fad, Mohamed *et al.* (2013) up to 45 Kg N/fad and Abd El-Haleem *et al.* (2019) up to 20 Kg N/fad.

It is clearly evident from Table (3) that fertilizing faba bean plants with 60 Kg N/fad produced the widest leaves area per plant at 96 days from sowing followed by 40 and 20 Kg N/fad, respectively with significant

variations among them in the two seasons. Also, the high level of nitrogen fertilization 60 Kg N/fad exceeded significantly 40 Kg N/fad plus spraying with 1% urea in leaves area per plant during the two seasons.

Nitrogen levels of 40 Kg N/fad plus spraying plants with 1% urea and 40 Kg N/fad alone resulted statistically similar leaves area per plant at 96 days from sowing, but significantly higher than 20 Kg N/fad in the two seasons as shown in Table (3).

The relative increases in leaves area/plant by applying 60 Kg N/fad compared to 40 Kg N/fad plus spraying with 1% urea, 40 and 20 Kg N/fad were 17.80%, 20.31% and 47.89%, respectively in the first season and 18.37%, 21.93% and 50.89%, respectively in the second season (Table 3). These results were expected since nitrogen stimulates cell division and extension, photosynthesis rate, metabolic activity in turn increases leaves area per plant.

Similar results were revealed by Shaaban *et al.* (2006) who noticed that leaves area/plant was increased by increasing N rate up to 40 Kg N /fad and Basdemir *et al.* (2020) up to 40 Kg N/ha.

**Table (3):** Effect of nitrogen fertilization, spraying with chelated iron and their interaction on leaves area /plant (cm<sup>2</sup>) at 96 days from sowing during the two seasons of 2019/2020 and 2020/2021

Chelated iron (ppm)	Nitrogen fertilization (Kg N /fad)				Average
	20	40	60	40+urea	
<b>2019/2020 season</b>					
Tap water	1525.66	1868.66	2241.66	1920.66	1889.16 C
750	1691.66	2076.66	2500.00	2124.66	2098.25 B
1500	1850.66	2284.66	2753.66	2317.66	2301.66 A
Average	1689.33 C	2076.66 B	2498.44 A	2121.00 B	
L.S.D 0.05 (N x Fe)	80.39				
<b>2020/2021 season</b>					
Tap water	1598.66	1971.66	2397.66	2043.66	2002.91 C
750	1773.66	2191.66	2673.66	2261.66	2225.16 B
1500	1940.66	2411.66	2945.66	2467.66	2441.41 A
Average	1771.00 C	2191.66 B	2672.33 A	2257.66 B	
L.S.D 0.05 (N x Fe)	86.45				

Data in Table (4) reveal that increasing nitrogen fertilization level from 20 to 40 and 60 Kg N/fad gave significant increases in leaf area index of faba bean at 96 days from sowing. Also, the high rate of nitrogen 60 Kg N/fad significantly surpassed 40 Kg N/fad plus spraying with 1% urea and that was true in both seasons.

Applying 40 Kg N/fad plus foliar spraying with 1% urea reflected increases in leaf area index at 96 days from sowing significant compared to 20 Kg N/fad and insignificant with 40 Kg N/fad alone during the two seasons (Table 4).

Faba bean plants treated by 60 Kg N/fad overcome 40 Kg N/fad plus spraying with 1% urea, 40 and 20 Kg N/fad in leaf area index at 96 days from sowing by 17.81%, 20.36% and 48%, respectively in the first season and 18.40%, 21.92% and 50.85%, respectively in the second season (Table 4). The increase in leaf area index by applying N might be attributed to the increase in leaves area per plant. In harmony with these results, Diaz and Manrique (1995) showed that leaf area index of faba bean was increased by increasing N rate up to 60 Kg N/ha.

**Table (4):** Effect of nitrogen fertilization, spraying with chelated iron and their interaction on leaf area index at 96 days from sowing during the two seasons of 2019/2020 and 2020/2021

Chelated iron (ppm)	Nitrogen fertilization (Kg N /fad)				
	20	40	60	40+urea	Average
<b>2019/2020 season</b>					
Tap water	6.09	7.46	8.95	7.67	7.54 C
750	6.76	8.32	10.00	8.50	8.39 B
1500	7.39	9.13	11.01	9.26	9.20 A
Average	6.75 C	8.30 B	9.99 A	8.48 B	
L.S.D 0.05 (N x Fe)	0.231				
<b>2020/2021 season</b>					
Tap water	6.39	7.88	9.58	8.17	8.00 C
750	7.09	8.76	10.69	9.04	8.89 B
1500	7.75	9.64	11.77	9.86	9.76 A
Average	7.08 C	8.76 B	10.68 A	9.02 B	
L.S.D 0.05 (N x Fe)	0.244				

The results recorded in Table (5) reveal that increasing nitrogen fertilization level up to 60 Kg N/fad significantly outweighed total dry weight per plant at 96 days from sowing, which also significantly surpassed 40 Kg N/fad plus spraying with 1% urea and that was true during both seasons (Table 5).

Total dry weight per plant of faba bean tended to increase significantly by applying 40 Kg N/fad plus spraying with 1% urea compared to 20 Kg N/fad, similar trend was observed with 40 Kg N/fad but the increase was not high enough to reach the 5% level of significance in the two seasons as shown in Table (5).

Faba bean plants received 60 Kg N/fad outweighed those fertilized by 40 Kg N/fad plus spraying with 1% urea, 40 and 20 Kg N/fad in total dry

weight per plant at 96 days from sowing by 15.76%, 19.14% and 47.49%, respectively in the first season and 16.71%, 19.74% and 48.73%, respectively in the second season (Table 5). These results were expected since nitrogen encourages meristemic activity, photosynthesis rate, metabolic processes and leaves area per plant in turn increases the amount of metabolites synthesized by the leaves in addition to formation of plant organs therefore total dry weight per plant was increased.

These results agree with those recorded by Fathy *et al.* (2007) who demonstrated that total dry weight per plant was increased by increasing N level up to 50 Kg N/fad, El-Tantawy and Nawar (2013) up to 60 Kg N/fad and Basdemir *et al.* (2020) up to 40 Kg N/ha.

**Table (5):** Effect of nitrogen fertilization, spraying with chelated iron and their interaction on total dry weight per plant (g) at 96 days from sowing during the two seasons of 2019/2020 and 2020/2021

Chelated iron (ppm)	Nitrogen fertilization (Kg N /fad)				
	20	40	60	40+urea	Average
<b>2019/2020 season</b>					
Tap water	29.39	36.29	43.00	37.57	36.56 C
750	31.29	38.69	46.19	39.83	39.00 B
1500	32.99	41.00	49.00	41.98	41.24 A
Average	31.33 C	38.66 B	46.06 A	39.79 B	
L.S.D 0.05 (N x Fe)	1.72				
<b>2020/2021 season</b>					
Tap water	30.57	37.79	44.94	38.77	38.02 C
750	32.63	40.48	48.56	41.64	40.82 B
1500	34.55	43.16	51.94	44.18	43.46 A
Average	32.59 C	40.48 B	48.47 A	41.53 B	
L.S.D 0.05 (N x Fe)	1.78				

The results recorded in Table (6) reveal that fertilizing faba bean plants with 60 Kg N/fad produced the highest total chlorophyll content at 96 days from sowing followed by 40 and 20 Kg N/fad, respectively with significant differences among them in the two seasons.

Faba bean plants received 40 Kg N/fad plus spraying with 1% urea was statistically in par with those fertilized by 40 Kg N/fad in total chlorophyll content at 96 days from sowing, however both treatments significantly overcome 20 Kg N/fad in the two seasons (Table 6).

Fertilizing faba bean plants with 60 Kg N/fad exceeded 40 Kg N/fad plus spraying with 1% urea, 40

and 20 Kg N/fad in total chlorophyll content at 96 days from sowing by 14.67%, 19.15% and 45.12%, respectively in the first season and 15.34%, 19.75% and 46.33%, respectively in the second season (Table 6). The increase in total chlorophyll content at 96 days from sowing by increasing nitrogen fertilization might be attributed to that nitrogen is a constituent of chlorophyll pigment which was reflected positively in increasing total chlorophyll content. These findings are in a same trend with those noticed by Sadek (2010) who revealed that total chlorophyll content was increased by increasing N rate up to 20 Kg N/fad, Ghalwash *et al.* (2012) up to 30 Kg N/fad and El-Tantawy and Nawar (2013) up to 60 Kg N/fad.

**Table (6):** Effect of nitrogen fertilization, spraying with chelated iron and their interaction on total chlorophyll content (SPAD units) in leaves at 96 days from sowing during the two seasons of 2019/2020 and 2020/2021

Chelated iron (ppm)	Nitrogen fertilization (Kg N /fad)				
	20	40	60	40+urea	Average
<b>2019/2020 season</b>					
Tap water	34.49	41.70	49.84	43.51	42.36 C
750	38.09	46.50	55.12	48.34	47.01 B
1500	41.49	50.76	60.59	52.54	51.35 A
Average	38.03 C	46.32 B	55.19 A	48.13 B	
L.S.D 0.05 (N x Fe)	2.60				
<b>2020/2021 season</b>					
Tap water	34.51	41.82	50.17	43.60	42.53 C
750	38.13	46.65	55.58	48.43	47.20 B
1500	41.44	50.94	61.21	52.70	51.57 A
Average	38.03 C	46.47 B	55.65 A	48.25 B	
L.S.D 0.05 (N x Fe)	2.69				

Data in Table (7) show that increasing nitrogen fertilization level up to 60 Kg N/fad induced significant increase in seed crude protein percentage. Moreover, it exceeded significantly the treatment of 40 Kg N/fad plus spraying with 1% urea and that held true in the two seasons.

Seed crude protein percentage tended to increase significantly by fertilizing faba bean plants by 40 Kg N/fad plus spraying with 1% urea compared to 20 Kg N/fad, similar trend was observed with 40 Kg N/fad but the increase was not high enough to reach the 5% level of significance and that was true during the two seasons as given in Table (7).

Faba bean plants received 60 Kg N/fad exceeded those treated by 40 Kg N/fad plus spraying with 1% urea, 40 and 20 Kg N/fad in seed crude protein

percentage by 6.32%, 9.61% and 23.65%, respectively in the first season and 6.10%, 9.12% and 22.83%, respectively in the second season (Table 7). The increase in seed crude protein percentage by applying N fertilization might be due to that N is a constituent of amino acids and proteins (Marschner, 1986).

Confirming results were illustrated by Osman *et al.* (2010) who mentioned that seed crude protein percentage of faba bean was increased by applying nitrogen fertilization up to 43 Kg N/ha, Sadek (2010) up to 20 Kg N/fad, El-Khateeb *et al.* (2012) up to 57 Kg N/fad, Abou-Amer *et al.* (2014) up to 60 Kg N/fad, Ashoori (2014) up to 50 Kg N/ha, Fouda *et al.* (2015) up to 20 Kg N/fad and Adak and Kibritci (2016) up to 60 Kg N/ha.

**Table (7):** Effect of nitrogen fertilization, spraying with chelated iron and their interaction on seed crude protein percentage during the two seasons of 2019/2020 and 2020/2021

Chelated iron (ppm)	Nitrogen fertilization (Kg N /fad)				Average
	20	40	60	40+urea	
<b>2019/2020 season</b>					
Tap water	24.57	27.65	30.14	29.10	27.87 C
750	26.94	30.38	33.28	31.32	30.48 B
1500	29.30	33.10	36.49	33.54	33.11 A
Average	26.93 C	30.38 B	33.30 A	31.32 B	
L.S.D 0.05 (N x Fe)	1.27				
<b>2020/2021 season</b>					
Tap water	24.37	27.39	29.73	28.75	27.56 C
750	26.69	30.03	32.75	30.90	30.09 B
1500	29.00	32.67	35.83	33.01	32.63 A
Average	26.68 C	30.03 B	32.77 A	30.89 B	
L.S.D 0.05 (N x Fe)	1.48				

**B- Effect of foliar spraying with chelated iron:-**

Data in Table (1) show that increasing chelated iron concentration from zero to 750 and 1500 ppm significantly increased faba bean plant height at 96 days from sowing and that held true in the two seasons 2019/2020 and 2020/2021. The relative increases in plant height at 96 days from sowing by spraying faba bean with 1500 ppm chelated iron compared to 750 ppm and zero (control) were 7.11% and 15.58%, respectively in the first season and 9.38% and 18.02%, respectively in the second season (Table 1). In harmony with these results, El-Gizawy (2003) recorded that plant height of faba bean increased by spraying plants with 0.5 g/L of chelated iron, Abdo and Attia (2007) by spraying with 200 ppm iron, Fusial *et al.* (2012) by spraying with 150 ppm chelated iron, Abd El-Razek *et al.* (2013) by spraying with 4 g/L of iron, Salem *et al.* (2014) by spraying with 4 g/L of iron, Al-Zubaidy and Al-Bawee (2018) by spraying with 200 ppm chelated iron, Alabboudh and Saad (2019) by spraying with 100 ppm chelated iron and Nour El-Din *et al.* (2020) by spraying with 0.5 g/L of chelated iron.

Data presented in Table (2) illustrate that here were significant increases in number of branches per plant at 96 days from sowing in the two seasons as chelated iron concentration increased up to 1500 ppm. The relative increases in number of branches/plant by foliar application of 1500 ppm chelated iron compared to 750 ppm and unsprayed control were 11.11% and 26.02%, respectively in the first season and 11.03% and 25.81%, respectively in the second season. In harmony with these results, El-Gizawy (2003) recorded that spraying faba bean plants with 0.5 g/L of chelated iron increased number of branches/plant, Fusial *et al.* (2012) by spraying with 150 ppm chelated iron and El-Mansy *et al.* (2021) by spraying broad bean with 500 ppm chelated iron.

Data in Table (3) show that faba bean plants sprayed with 1500 ppm chelated iron produced the widest leaves area per plant at 96 days from sowing compared to 750 ppm and unsprayed control with significant differences among the three concentrations and that held true in the two growing seasons. Spraying faba bean plants with 1500 ppm chelated iron reflected increases in leaves area/plant at 96 days from sowing compared to 750 ppm and unsprayed control by 9.69% and 21.83%, respectively in the first season and 9.72% and 21.89%, respectively in the second season. Similar results were reported by Abdo and Attia (2007) who mentioned that leaves area per plant of faba bean was increased by foliar application of 200 ppm iron, Salem *et al.* (2014) by spraying with 4 g /L of iron and Al-Zubaidy and Al-Bawee (2018) by spraying with 200 ppm chelated iron.

Data presented in Table (4) illustrate that here were consistent and remarkable increases in faba bean leaf area index at 96 days from sowing as chelated iron concentration increased from zero to 750 and 1500 ppm with significant differences among them and that held true in both seasons. Faba bean plants sprayed with 1500 ppm chelated iron overcome those treated by 750 ppm and unsprayed control in leaf area index at 96 days from sowing by 9.65% and 22.02%, respectively in the first season and 9.79% and 22%, respectively in the second season (Table 4). These results are in a good line with those noticed by Salem *et al.* (2014) who stated that leaf area index of faba bean was increased by spraying plants with 4 g /L of iron and Alabboudh and Saad (2019) with 100 ppm chelated iron.

The data presented in Table (5) show that faba bean plants sprayed with 1500 ppm chelated iron outweighed those received 750 ppm and unsprayed control with significant variations among the three concentrations in total dry weight per plant at 96 days from sowing and that held true in the two growing

seasons. The relative increases in total dry weight per plant at 96 days from sowing by spraying plants with 1500 ppm chelated iron compared to 750 ppm and unsprayed control were 5.74% and 12.81%, respectively in the first season and 6.47% and 14.31%, respectively in the second season. These results were expected since iron encourages various enzymatic systems, metabolic processes, synthesis of protein and chlorophyll as well as photosynthesis rate in turn increases the amount of metabolites synthesized by the leaves in addition to formation of plant organs finally total dry weight per plant was increment. Many investigators revealed that total dry weight per plant was increased by spraying with iron, El-Tantawy and Nawar (2013) by spraying broad bean with 500 ppm iron, Salem *et al.* (2014) by spraying faba bean with 4 g /L of iron, Al-Zubaidy and Al-Bawee (2018) by spraying faba bean with 200 ppm chelated iron and El-Mansy *et al.* (2021) by spraying broad bean with 500 ppm chelated iron.

The results recorded in Table (6) reveal that increasing chelated iron concentration up to 1500 ppm significantly increased total chlorophyll content at 96 days from sowing and that held true in both seasons. Spraying faba bean plants with 1500 ppm chelated iron surpassed 750 ppm and unsprayed control in total chlorophyll content at 96 days from sowing by 9.23% and 21.14%, respectively in the first season and 9.26% and 21.26%, respectively in the second season. The increase in total chlorophyll content by spraying faba bean plants with chelated iron might be due to that iron enhances synthesis of chlorophyll (Marschner, 1986). These results are in accordance with those detected by Abdo and Attia (2007) who stated that chlorophyll content was increased by spraying faba bean with 200 ppm iron, El-Tantawy and Nawar (2013) by spraying broad bean with 500 ppm iron, Al-Hiji (2014) by spraying faba bean with 150 ppm chelated iron, Alabboudh and Saad (2019) by spraying faba bean with 100 ppm chelated iron and El-Mansy *et al.* (2021) by spraying broad bean with 500 ppm chelated iron.

Data in Table (7) show that there were consistent and remarkable increases in seed crude protein percentage as chelated iron concentration increased from zero to 750 and 1500 ppm with significant differences among the three concentrations and that was true in the two seasons. The relative increases in seed crude protein percentage by spraying faba bean plants with 1500 ppm chelated iron compared to 750 ppm and unsprayed control were 8.63% and 18.80%, respectively in the first season and 8.44% and 18.40%, respectively in the second season. The favorable effect of foliar spraying with chelated iron on seed crude protein percentage might be attributed to that iron enhances metabolic processes, various enzymes and nitrogen fixation by root nodules bacteria as well as stimulates synthesis of protein (Marschner, 1986). Similar results were detected by El-Gizawy (2003) who reported that seed crude protein percentage of faba bean was increased by spraying with 0.5 g /L of chelated iron, Abdo and Attia (2007) by spraying with 200 ppm iron, El-Shafey *et al.* (2019) by 4 g /L of chelated iron and Nour El-Din *et al.* (2020) by 0.5 g /L of chelated iron.

### C- Interaction effect:-

There was significant interaction between nitrogen fertilization and spraying with chelated iron on all growth characters at 96 days from sowing namely plant height, number of branches per plant, leaves area per plant, leaf area index, total dry weight of plant and total chlorophyll content as well as seed crude protein percentage of faba bean in the two seasons 2019/2020 and 2020/2021 (Tables 1-7).

The highest values of all aforementioned characters produced from plants fertilized by 60 Kg N/fad and sprayed with 1500 ppm chelated iron. While the lowest values were gained from plants received 20 Kg N /fad and unsprayed control in the two seasons (Tables 1-7). These results are in harmony with those recorded by Caliskan *et al.* (2008), El-Tantawy and Nawar (2013), Doklega (2015) and Pal *et al.* (2019).

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## تأثير التسميد الأزوتي والرش الورقي بالحديد المخلبي على نمو وجودة الفول البلدي في الأراضي الرملية

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أجريت تجربتان حقلية في موسمي 2019/2020 و 2020/2021 بمنطقة القصاصين بمحافظة الإسماعيلية لدراسة تأثير أربع معاملات من التسميد الأزوتي هي 20، 40، 60 كجم أزوت/فدان بالإضافة إلى 40 كجم أزوت/فدان مع الرش الورقي باليوريا بتركيز 1% وكذلك ثلاث معاملات من الرش الورقي بالحديد المخلبي (12,5% حديد) هي الرش بالماء (كنترول)، 750، 1500 جزء في المليون على نمو وجودة الفول البلدي صنف نوبارية 3 في الأراضي الرملية بمحافظة الإسماعيلية. ويمكن تلخيص النتائج كما يلي:-

- 1- أدى زيادة معدل التسميد الأزوتي حتى 60 كجم أزوت/فدان إلى زيادة معنوية في كل صفات النمو الخضري وهي ارتفاع النبات وعدد الأفرع/نبات ومساحة الأوراق/نبات ودليل مساحة الأوراق والوزن الجاف الكلي/نبات ومحتوى الكلوروفيل الكلي وكذلك النسبة المئوية للبروتين بالبذور.
- 2- تفوقت معاملة 60 كجم أزوت/فدان معنويا على معاملة 40 كجم أزوت/فدان مع الرش الورقي باليوريا بتركيز 1% في كل الصفات السابقة.
- 3- أدى زيادة تركيز الحديد المخلبي حتى 1500 جزء في المليون إلى زيادة معنوية في كل صفات النمو الخضري وكذلك النسبة المئوية للبروتين بالبذور.
- 4- يوجد تأثير معنوي للتفاعل بين التسميد الأزوتي والرش الورقي بالحديد المخلبي على كل الصفات السابقة. وقد أمكن الحصول على أعلى القيم لجميع الصفات السابقة بالتسميد بمعدل 60 كجم أزوت/فدان والرش الورقي بالحديد المخلبي بتركيز 1500 جزء في المليون.

**الكلمات الدالة:** الفول البلدي، التسميد الأزوتي، الرش بالحديد، صفات النمو، جودة المحصول